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UNITED STATES PATENT APPLICATION

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FOR

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9

UNDERFLOOR CABLE JUNCTION UNIT AND COMPUTER CENTER EQUIPPED

10

WITH SUCH JUNCTION UNITS

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Inventor:

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Traugott MARQUARDT

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## FIELD OF THE INVENTION

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## BACKGROUND OF THE INVENTION

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The present invention relates generally to the provision of data cable connections for computers in a computer center, and, for example, to an underfloor cable junction unit as well as a computer center equipped with such junction units.

A raised-floor system is used where it is desirable to maintain ready access below the floor surface to cables, wiring, etc. Such access floor systems are used extensively in computer and control rooms. They have a discrete modular structure, made up of module floor panels which are supported above a base floor by a plurality of upright support columns. Raised-floor systems for computer rooms are, for example, disclosed in US 5,467,609 A and US 6,370,831 B1.

Normally, computers produce a considerable amount of heat, so that computer rooms have to be air-conditioned. The volume between the base floor and the raised floor of a raised-floor system can be used as a cooling air supply duct. Typically, the cooling air enters this volume at one side of the computer room and leaves the volume upwardly through floor panels with cooling air outlets distributed over the computer room (see, for example, JP 2002061911 A).

Usually, computers have to be connected to active network elements, such as routers and switches, with data transmission cables, in the form of copper cables or optical fiber cables. These data cables run below the raised floor so as to keep the surface of the raised floor free of obstacles in order to provide the operators free access to the computer equipment. An example of a raised-floor system with underfloor cable trays is disclosed in US 2002/0003194 A1.

Cabling a computer room uniquely for a particular computer configuration would be very inflexible. For example, if in a certain part of the computer room existing computers are replaced by computers requiring a different type of data cable or having a higher port density, existing data cables would have to be replaced (which

1 is hardly possible) or additional data cables would have to be laid. Therefore, to  
2 enable a computer room to be used in a flexible way, computer rooms are usually  
3 equipped from the outset with a universal data cabling. For example, such a universal  
4 cabling includes as many copper cables and optical monomode and multimode fiber  
5 cables as required for all expected future computer configurations. The cables end at  
6 cable junction units which are distributed throughout the computer room. These data  
7 cables and their respective junction units are permanently installed and are not  
8 changed, even when the computer configuration is changed. The ports of each  
9 computer are connected to one or more nearby junction units by means of (normally  
10 flexible) patch cables. Only the patch cable cabling is changed when the computer  
11 configuration changes.

12 In raised-floor systems, data cable junction units are usually disposed below  
13 the surface of the raised floor. Underfloor junction boxes for use in general office  
14 areas are, for example, described in US 5,673,522 A, US 5,149,277, US 5,340,326,  
15 and JP 10028313 A. WO 98/322204 and JP 07087651 A disclose junction units with  
16 two rows of connectors.

17 A prior art underfloor cable junction unit used in computer room installations  
18 is shown in Fig. 8 which is a perspective view of a part of a computer room with a  
19 raised-floor system in which the floor panels are shown to be transparent. On a base  
20 floor 1, floor columns 2 support floor panels 3 which together form a raised floor 4.  
21 The raised-floor system is a modular system in which the floor panels 3 are typically in  
22 the form of squares, for example with the dimension of 60 cm x 60 cm which rest on a  
23 square frame which in turn rests on the floor columns 2 arranged at the square  
24 corners. The height of the raised floor is typically 50 cm to 70 cm, but there are also  
25 installations of only about 30 cm. Computers 5 (only two of them are shown in Fig. 8)  
26 are placed on the raised floor 4.

27 Whereas the basic type of floor panel 3 has a completely closed surface,  
28 there are special floor panels with cooling air outlets 6 and floor panels with a cable  
29 aperture 7. Cooling air 8 flows in the volume under the raised floor 4 in a certain  
30 direction (from right to left in Fig. 8), and at each floor panel 3a some of the cooling

1 air is branched off upwardly, flows through the cooling air outlets 6 and is partly  
2 sucked in by the nearby computers 5.

3 The room under the raised floor 4 also accommodates the cabling of the  
4 computer room. For example, in Fig. 8 bunches 9 of data cables run from a data  
5 communication room (not shown in Fig. 8) on the left-hand side of Fig. 8 on the base  
6 floor 1 from the left to the right in Fig. 8 (only one cable bunch 9 is shown in Fig. 8).  
7 The cable bunches comprise individual data cables 10 or bundles 12 of data cables  
8 which run in trough-like cable trays (not shown in Fig. 8) which define a cable route  
9 and thereby form the cable bunches 9. A plurality of underfloor cable junction units 11  
10 are arranged throughout the computer room under the raised floor 4, one of which is  
11 illustrated in Fig. 8. The cable junction unit 11 is a closed box mounted on a support  
12 13 closely below a floor panel 3 of the raised floor 4. The support 13 is C-shaped,  
13 wherein the lower leg 14 of the "C" is fixed to the base floor 1 and the junction unit 11  
14 is mounted on the upper leg 15 of the "C". The cable bunch 9 runs over the lower leg  
15 14. The junction unit 11 has a cable bundle inlet 16 at one of its faces and a row 17 of  
16 connectors or ports 18 at either lateral side. In the example of Fig. 8, the junction unit  
17 11 has two rows 17 of eight connectors 18, i.e. sixteen connectors or ports 18 in total.  
18 One of the cable bundles 12 branches off from the cable bunch 9 and runs upwardly  
19 to the cable bundle inlet 16. Inside the box-shaped junction unit 11, the cable bundle  
20 12 is separated into individual cables 10 which are here connected to the cable  
21 connectors 18. If the cables 10 are copper cables, the cable connectors 18 are  
22 typically RJ45, RJ11, 25-pin sub-D, V35, X21, or RS232 connectors. If the cable  
23 bundle 9 is an optical bundle cable, the junction unit serves as a splice box, in which,  
24 upon installation, the optical bundle cable is separated into individual optical fibers,  
25 the ends of which are then manually spliced with the (optical) connectors 18 within the  
26 junction unit 11. The optical cable connectors are typically SC, ST, E2000, MTRJ or  
27 LC connectors.

28 The cabling described so far, is permanent, i.e. it is not changed when the  
29 configuration of computers 5 to be connected is changed. Rather, the part of the  
30 cabling which is adaptable to a particular computer configuration is constituted by  
31 patch cables 19 with suitable cable connectors 20 at both ends. The (typically flexible)

1 patch cables 19 connect the connectors 18 with computer ports 21. They run from the  
2 junction units 11 below the raised floor 4, pass through the cable aperture 7 next to  
3 the computer 5 to be connected, and then run on the raised floor 4 to the computer 5.

4 Although junction units of the type described in Fig. 8 were considered  
5 sufficient in the past, there remains a need to provide an improved underfloor cable  
6 junction unit and computer centers equipped with such improved junction units.

## 7 8 SUMMARY OF THE INVENTION 9

10 A first aspect of the invention is directed to an underfloor cable junction unit for  
11 installation in a raised-floor system used as cooling air supply duct for devices  
12 arranged on the raised floor and having floor panels with cooling air outlets.  
13 According to the first aspect, the junction unit has a top side, which, or at least a  
14 major part of which, is open to enable the passage of cooling air through the top side  
15 toward a floor panel with cooling air outlets.

16 According to another aspect, an underfloor cable junction unit for installation in a  
17 raised-floor system used as cooling air supply duct is provided. The junction unit has  
18 opposite faces and comprises rows of connectors arranged on at least two levels  
19 one above the other at at least one of the faces. Open slits are provided in at least  
20 one of the faces between the rows of connectors to facilitate the passage of cooling  
21 air through the junction unit from face to face.

22 According to another aspect, an underfloor cable for installation in a raised-floor  
23 system. The junction unit has opposite faces and comprises slide-in connector units  
24 able to be slid into the junction unit at at least one of its faces from outside. The slide-  
25 in connector units are arranged on at least two levels in the junction unit, one above  
26 the other.

27 According to another aspect, an underfloor cable junction unit with rows of  
28 connectors for installation in a raised-floor system is provided. The junction unit has a  
29 frame structure with a frame. The frame comprises portal-like front parts and sidebars  
30 connecting the front parts, such that the portal like front parts are arranged opposite  
31 each other.

1 According to another aspect, an underfloor cable junction unit for installation in a  
2 raised-floor system is provided. The junction unit has faces and lateral sides. At least  
3 one of the faces is equipped with rows of connectors. At least one horizontal sidebar  
4 is arranged at each of the lateral sides, wherein the sidebar is arranged to enable  
5 permanent cables coming from the inner side of connector rows to pass above and  
6 outwardly of the sidebar downwardly to a base floor and to be fixed to the sidebar.

7 According to another aspect, a computer center having a raised floor on which  
8 computers are arranged is provided. The raised floor is arranged as cooling air  
9 supply duct for the computers and has floor panels with cooling air outlets. It is  
10 equipped with underfloor cable junction units by which the computers are connected  
11 to permanent data cables running under the raised floor. The junction unit has a top  
12 side, wherein the top side or at least a major part of it is open to enable the passage  
13 of cooling air through the top side toward a floor panel with cooling air outlets.

14 According to another aspect, a computer center having a raised floor on which  
15 computers are arranged is provided. The raised floor is arranged as cooling air  
16 supply duct for the computers. It is equipped with underfloor cable junction units by  
17 which the computers are connected to permanent data cables running under the  
18 raised floor. The junction unit has opposite faces and comprises rows of connectors  
19 arranged on at least two levels one above the other at at least one of the faces. Open  
20 slits are provided in at least one of the faces between the rows of connectors to  
21 facilitate the passage of cooling air through the junction unit from face to face.

22 According to another aspect, a computer center having a raised floor on which  
23 computers are arranged is provided. The raised floor is equipped with underfloor  
24 cable junction units by which the computers are connected to permanent data cables  
25 running under the raised floor. The junction unit has opposite faces and comprises  
26 slide-in connector units able to be slid into the junction unit at at least one of its faces  
27 from outside. The slide-in connector units are arranged on at least two levels in the  
28 junction unit, one above the other.

29 According to another aspect, a computer center having a raised floor on which  
30 computers are arranged is provided. The raised floor is equipped with underfloor  
31 cable junction units by which the computers are connected to permanent data cables

1 running under the raised floor. The junction unit has a frame structure with a frame.  
2 The frame comprising portal-like front parts and sidebars connecting the front parts,  
3 such that the portal like front parts are arranged opposite each other.

4 According to another aspect, a computer center having a raised floor on which  
5 computers are arranged is provided. The raised floor is equipped with underfloor  
6 cable junction units by which the computers are connected to permanent data cables  
7 running under the raised floor. The junction unit having faces and lateral sides. At  
8 least one of the faces is equipped with rows of connectors. At least one horizontal  
9 sidebar is arranged at each of the lateral sides. The sidebar is arranged to enable  
10 permanent cables coming from the inner side of connector rows to pass above and  
11 outwardly of the sidebar downwardly to a base floor and to be fixed to the sidebar.  
12 This arrangement obviates that the flow of cooling air is constricted by the permanent  
13 cables. Accordingly, it enables a small cooling air flow resistance to be achieved.

14 Other features are inherent in the underfloor cable junction unit and the  
15 computer center disclosed or will become apparent to those skilled in the art from the  
16 following detailed description of embodiments and its accompanying drawings.

## 17 DESCRIPTION OF THE DRAWINGS

18  
19  
20 Embodiments of the invention will now be described, by way of example, and  
21 with reference to the accompanying drawings, in which:

22 Fig. 1 illustrates, in a perspective view, a part of an exemplary computer  
23 room with computers arranged on a raised floor and an embodiment of an underfloor  
24 cable junction unit;

25 Fig. 2 shows a more detailed side view of the underfloor cable junction unit of  
26 Fig. 1;

27 Fig. 3 shows a more detailed front view of the underfloor cable junction unit of  
28 Fig. 1;

29 Fig. 4 shows a more detailed top view of the underfloor cable junction unit of  
30 Fig. 1;

1           Fig. 5 shows a cut-out of the front view of Fig. 3, in which a curved cable  
2 guide is visible;

3           Fig. 6 illustrates schematically another embodiment which adjustable height  
4 and width;

5           Fig. 7 illustrates schematically a computer center equipped with underfloor  
6 cable junction units as shown in Figs. 1 to 6;

7           Fig. 8 illustrates, in a perspective view similar to Fig. 1, a part of a computer  
8 room with computers arranged on a raised floor and underfloor cable junction units,  
9 as used in the prior art.

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#### 11                                   DESCRIPTION OF THE PREFERRED EMBODIMENTS

12

13           Fig. 1 illustrates, in a perspective view, a part of an exemplary computer  
14 room with computers arranged on a raised floor and an embodiment of an underfloor  
15 cable junction. Before proceeding further with the description, however, a few items of  
16 the embodiments will be discussed.

17           As mentioned at the outset, the volume under the raised floor of a raised-floor  
18 system is often used as a cooling air supply duct. Although in Fig. 8 only one floor  
19 panel with cooling air outlets beneath the module with the cable junction unit is shown,  
20 it is sometimes desired that such floor panels with cooling air outlets can also be  
21 disposed directly above cable junction units. However, since the prior art junction unit  
22 illustrated in Fig. 8 forms an obstacle for upwardly flowing air, due to its closed-box  
23 shape, a "hot spot" can arise above such a prior art junction unit, if a floor panel with  
24 cooling air outlets is disposed directly above it. A "hot spot" describes an air volume  
25 above the raised floor in which the temperature is considerably higher than the  
26 corresponding average temperature in the computer room. Such a local temperature  
27 increase may cause a malfunction of the adjacent computers. In order to avoid such  
28 "hot spots" when a floor panel with cooling air outlets is disposed directly above a  
29 junction unit, in some of the embodiments the top side of the underfloor cable junction  
30 unit or at least a major part of it is open to enable the passage of cooling air through



1 it. In some embodiments, the lateral sides of the junction unit or at least a major part  
2 of them are also open, so as to improve the cooling air circulation.

3 Typically, the main direction of flow of the cooling air is parallel to the cable  
4 bunches. The junction units will normally be arranged such that their faces are  
5 oriented perpendicularly to the main direction of the cooling air flow. In order to  
6 facilitate the passage of cooling air through the junction units from face to face, in  
7 some of the embodiments open slits are provided in the perpendicularly arranged  
8 face of the junction unit between connector rows of the junction unit so as to diminish  
9 the cooling air flow resistance.

10 In some of the embodiments the connector rows are arranged on at least two  
11 levels one above the other. This enables higher port densities to be achieved (i.e.  
12 number of ports per floor module or per square meter) than in single-level  
13 arrangements, for example a port density higher by a factor 8 to 24. Since the  
14 development of server computer technology has led to an ever-increasing number of  
15 ports per footprint of a server computer, the port density provided by an underfloor  
16 cable junction unit may be the limiting factor for the number of computers with which a  
17 given computer room can be equipped. Therefore, the embodiments with a multi-level  
18 arrangement of the connector rows enable a computer room to be equipped with a  
19 relatively large number of computers.

20 In some of the embodiments, the rows of connectors are accommodated by  
21 slide-in units which can be slid into the junction unit on different levels at its faces from  
22 the outside. For example, the slide-in units are standard 19-inch units. For example,  
23 each 19-inch unit has 24 linearly arranged connectors, such as RJ45, RJ11, 25-pin  
24 sub-D, V35, X21, RS232, SC, ST, E2000, MTRJ and/or LC connectors (this  
25 enumeration is only exemplary; any connector type may be used). RJ45 connectors,  
26 for example, may be Category 5 or 6 connectors (according to the standard EN  
27 50173).

28 The slide-in units may be fixed to the junction unit in a dismountable manner  
29 (e.g. by means of screws or clamps) to enable them to be removed, replaced or  
30 changed in their position or to enable further slide-in units to be mounted, without  
31 dismounting the junction unit.

1           Whereas the prior art junction units illustrated in Fig. 8 are only single-type  
2 units (i.e. they provide either copper data cable connectors or optical fiber  
3 connectors), in some of the embodiments the connector rows are at least one of  
4 copper data cable connector rows or optical fiber connector rows. In other words,  
5 these embodiments can optionally be equipped with data cable connector rows and  
6 optical fiber connector rows, thereby realizing a mixed-type junction unit.

7           In those embodiments of the junction unit equipped with optical fiber  
8 connector rows the optical fiber connectors are preferably of a connector type which  
9 enables pre-fabricated optical break-out cables, which have pre-installed cable  
10 connectors, to be plugged in at a permanent cable connection side of the junction unit  
11 connectors, without using a splice box. An exemplary optical fiber connection system  
12 is the E2000 system. In this system, both permanent cables and patch cables bear  
13 the same connectors, and the junction unit connectors are feed-through connectors,  
14 into which a permanent cable connector and a patch cable connector are plugged  
15 from the two opposite sides. The permanent cable connector can be fixed in the  
16 respective junction unit connector by removing a detent clip from the permanent cable  
17 connector which is normally to be depressed if a plugged-in connector is to be  
18 unplugged. The fact that no splice box is required increases the achievable port  
19 density. In addition, the use of pre-fabricated optical break-out cables with pre-  
20 installed cable connectors facilitates the installation procedure and enhances the  
21 reliability of the optical connections. In a similar manner, pre-manufactured permanent  
22 copper cables may be used in order to obviate connector installation work in the  
23 computer room. For example, the permanent cables may be equipped with pre-  
24 installed female RJ45 connectors, and the patch cables with male RJ45 connectors.  
25 The junction unit connectors are then feed-through connectors that accommodate the  
26 pre-installed female RJ45-connectors from the permanent cable connection side of  
27 the junction unit, and enable the male RJ45-connectors to be plugged in from the  
28 outside of the junction unit.

29           In some of the embodiments, the rows of connectors are arranged at two  
30 opposing faces of the junction unit. The connectors are arranged such that the  
31 permanent cable connections are provided at the inner side of the connectors (i.e. the

1 side facing the inside of the junction unit), and plug-in patch cable connections are  
2 provided at the outer side of the connectors (i.e. the outward-facing side of the  
3 junction unit), which is, for example, in contrast to the junction unit disclosed in JP  
4 10028313 A, in which the permanent cable connections are provided at the junction  
5 unit's outer side. If the floor modules adjacent to the faces with the connector rows are  
6 left free (i.e. are not equipped with junction units or the like), the arrangement of the  
7 connectors enables a technician to access the connectors easily and establish or  
8 change patch cable connections, despite the high port density. The slits between the  
9 connector rows in the two opposing faces are preferably aligned in the horizontal  
10 direction the two opposing faces so as to minimize the cooling air flow resistance.

11 The faces of the cable junction unit are defined as those sides which are  
12 arranged perpendicularly to the longitudinal direction of the cable bunches running on  
13 the base floor, and the lateral sides of the cable junction unit are defined as those  
14 sides arranged parallel to this direction. In the prior art junction units illustrated in Fig.  
15 8, the permanent cables or cable bundles leave the cable unit in the center of its face  
16 and hang freely which impairs the face's accessibility and increases the risk of the  
17 permanent cable being damaged. In some of the embodiments, the junction unit  
18 further comprises at least one horizontal sidebar arranged at the lateral sides of the  
19 junction unit. The sidebar is positioned such that it enables permanent cables coming  
20 from the inner side of the connector rows to pass above and outwardly of the sidebar  
21 downwardly to the base floor. The permanent cables running in this way can be fixed  
22 to the sidebar, e.g. by cable ties. This improves the accessibility of the junction unit's  
23 faces (on which the connector rows are arranged in the embodiments) and eliminates  
24 the risk of the permanently connected cables being damaged.

25 Similarly, in the prior art junction unit illustrated in Fig. 8, the patch cables  
26 leave the junction unit in a manner which impairs the accessibility and, since the patch  
27 cables run freely through the volume under the raised floor, makes them prone to  
28 damage (e.g. if a floor panel is removed and a heavy object such as a tool is  
29 inadvertently dropped into the open floor module, a patch cable connector may easily  
30 be broken). Some of the embodiments, however, comprise patch cable guiding  
31 elements which are arranged laterally on the faces of the junction units which are

1 equipped with connector rows. These guiding elements enable patch cables plugged  
2 into the connectors to be guided laterally on the respective face of the junction unit  
3 downwardly to the base floor.

4         The junction unit of some of the embodiments has a frame structure. The  
5 frame comprises portal-like face parts and sidebars connected to the face parts,  
6 such that the face parts are arranged opposite each other. Several mounting  
7 positions are provided for the sidebars to enable them to be mounted at different  
8 heights. Permanent cables coming from the inner side of the connector rows pass  
9 above and outwardly of the sidebar downwardly to the base floor. In other words, the  
10 permanent cables are bent by about 90° from a horizontal into a vertical orientation.  
11 The height of the sidebar relative to the (nearest) connector row defines the minimum  
12 bending radius. Therefore, by choosing a certain vertical minimum distance between  
13 the sidebar and the (nearest) detector row, a required minimum bending radius can  
14 be ensured. Since the connector rows may be flexibly mounted at a desired height  
15 and connectors for different cable types requiring different minimum bending radii  
16 can be flexibly mounted, the fact that several mounting positions are provided for the  
17 sidebars provides full modular flexibility while enabling the junction unit to be set-up in  
18 a way which ensures the minimum bending radius for the cable type used in a  
19 specific case. Preferably, the sidebars are mounted to the face parts in a  
20 dismountable manner to enable them to be replaced or their mounting height to be  
21 changed. By this measure, the modular junction units can be adapted so as to ensure  
22 the minimum bending angle requirement even if they are already mounted, for  
23 example when additional detector rows are installed or existing detector rows are  
24 moved to different mounting positions.

25         Since in some of the embodiments, the junction unit is designed as an open  
26 frame rather than in the form of a closed box, the junction connectors themselves are  
27 preferably provided with enclosures. Such connector enclosures do not constrict the  
28 cooling air flow (or, at least, do not constrict it as much as the prior art closed-box  
29 design), while protecting the interior of the junction unit connectors from dirt etc.

30         In some embodiments the portal formed by the face parts is not closed at the  
31 bottom, i.e. has no horizontal bottom bar, but only two posts which rest on the base

1 floor. The cable junction unit can then be installed above an already existing cable  
2 bunch. This is advantageous when an already existing computer room installation is  
3 extended. In other embodiments the portal is closed at the bottom, i.e. the face parts  
4 have a horizontal bottom bar. These embodiments are used when the junction units  
5 are installed prior to the laying of the permanent cables.

6 In some embodiments the junction unit's height and/or width (e.g. the length of  
7 the sidebars) is variable which enables it to be adapted to different raised-floor  
8 heights and different floor module dimensions.

9 As was mentioned above, in the prior art the cable bunches running under the  
10 raised floor are usually guided by cable trays mounted on the base floor. In the some  
11 of the embodiments, both faces of the junction unit are open at least at their lower  
12 parts to enable bunches of permanent cables to pass through the junction unit,  
13 whereby the permanent cable bunches are encompassed and thereby guided. If  
14 several junction units are arranged in a series (e.g. in every second or third module of  
15 a row of floor modules) the junction units take over the guiding function of the prior art  
16 cables trays. Therefore, preferably, a computer room equipped with the junction units  
17 is not equipped with cable trays or the like, at least in those parts of the room which  
18 are equipped with the junction units.

19 Some of the embodiments of the underfloor cable junction unit are designed  
20 in a modular manner, the module parts of which are commercially available standard  
21 parts or are at least based on such standard parts. The modularity of the design  
22 enables the junction unit to be easily adapted to particular requirements of the data  
23 connections to be provided, to particular raised-floor heights, and to a certain extent,  
24 to particular dimensions of the floor panel modules. This adaptability has two  
25 aspects:

26 (i) adaptability to particular requirements at the time of the installation of the junction  
27 unit; and (ii) adaptability of an already installed junction unit to later changes of  
28 requirements. The embodiments are superior over the prior art design illustrated in  
29 Fig. 8 in both aspects. Several items regarding adaptability are discussed in more  
30 detail below.

1           In the embodiments, the cable junction unit is designed to be mounted on the  
2 base floor on which the raised floor is posted. The cable junction unit is dimensioned  
3 such that it can be lowered through a module opening which is present when a  
4 module panel of the discrete modular raised-floor system is removed.

5           The term "underfloor cable junction unit" is meant to include also cable  
6 junction units to be mounted in a suspended ceiling (hanging at the solid ceiling,  
7 above the suspended ceiling) or at a wall (for example, hanging laterally at the wall of  
8 a cable chute).

9           The described embodiments not only disclose underfloor cable junction units,  
10 but also a computer center having a raised floor on which computers are arranged.  
11 The volume under the raised floor is equipped with underfloor cables junction units as  
12 described above. The computers are connected to permanent data cables running  
13 under the raised floor by means of the junction units. An embodiment of the computer  
14 center further comprises active network elements and network element junction units.  
15 The permanent data cables permanently connect the underfloor cable junction units  
16 and the network element junction units. Patch cables for the connection of the  
17 computers to the underfloor cable junction units (also called "first patch cables") as  
18 well as patch cables for the connection of the active network elements to the network  
19 element junction units (also called "second patch cables") are provided.

20           Returning now to Fig. 1, it illustrates an embodiment of an underfloor cable  
21 junction unit 31 used in a computer room 32 with a raised-floor system in which the  
22 floor panels are shown to be transparent. On a base floor 1, floor columns 2 support  
23 floor panels 3 which together form a raised floor 4. The raised-floor system is a  
24 modular system in which the floor panels 3 are typically in the form of squares, for  
25 example with the dimension of 60 cm x 60 cm, which rest on a square frame which in  
26 turn rests on the floor columns 2 arranged at the square corners. The height of the  
27 raised floor is typically 50 cm to 70 cm, but there are also installations of only about  
28 30 cm. Computers 5 (only two of them are shown in Fig. 1) are placed on the raised  
29 floor 4.

30           Whereas the basic type of floor panel 3 has a completely closed surface,  
31 there are special floor panels with cooling air outlets 6 and floor panels with a cable

1 aperture 7. Cooling air 8 flows in the volume under the raised floor 4 in a certain  
2 direction (from right to left in Fig. 1), and at each floor panel 3a some of the cooling  
3 air is branched off upwardly, flows through the cooling air outlets 6 and is partly  
4 sucked in by the nearby computers 5. Although in Fig. 1 only one floor panel with  
5 cooling air outlets 6 beneath the module with the cable junction unit 31 is shown, in  
6 real applications a larger fraction of such floor panels will be used, and in particular,  
7 floor panels with cooling air outlets 6 are also disposed directly above cable junction  
8 units 31.

9         The room under the raised floor 4 also accommodates the cabling of the  
10 computer room 32. For example, in Fig. 1 bunches 9 of data cables run from a data  
11 communication room (not shown in Fig. 1) on the left-hand side of Fig. 1 on the base  
12 floor 1 from the left to the right in Fig. 1 (only one cable bunch 9 is shown in Fig. 1).  
13 The cable bunches 9 comprise individual data cables 10 or bundles 11 of data  
14 cables.

15         A plurality of underfloor cable junction units 31 are arranged throughout the  
16 computer room 32 under the raised floor 4, one of which is illustrated in Fig. 1. The  
17 cable junction unit 31 is a cube-like dimensioned open frame mounted directly on the  
18 base floor 1. It encompasses and thereby guides the cable bunch 9 so that cable  
19 trays or the like usually required in prior art installations as shown in Fig. 8 can be  
20 omitted. On each of the two faces 33 of the junction unit 31 there are rows 47 of  
21 connectors (or ports) 48 on three levels, one above the other. Since, for example, one  
22 row 47 has twenty-four connectors 48 only sixteen are shown in the figures, the total  
23 number of connectors 48 of the exemplary embodiment shown in Figs. 1 to 4 is  
24 higher by a factor nine compared to the prior art junction unit illustrated in Fig. 8. Due  
25 to the arrangement of the connectors 48 on the faces 33 of the junction unit 31, they  
26 are easily accessible from the floor module adjacent to the direction of the cable  
27 bunch 9, in spite of the high port density.

28         The cable junction unit 31 is equipped with rows 47 of copper cable  
29 connectors 48a (e.g. RJ45, RJ11, 25-pin sub-D, V35, X21, RS232 connectors) and  
30 optical fiber connectors 48b (e.g. SC, ST, E2000, MTRJ, LC connectors) in a mixed  
31 manner. If the optical cables used are pre-fabricated break-out cables with pre-

1 installed cable connectors, there is no need to equip the junction unit with splice  
2 boxes (however, of course, the junction unit may be equipped with one ore more  
3 splice boxes if, in a particular installation, optical cables that are not pre-fabricated  
4 break-out cables are used).

5 Open slits 36 are provided in the faces 33 of the junction unit 31 between the  
6 connector rows 47. These slits 36, together with the lower open part which enables  
7 the cable bunch 9 to pass through the junction unit 31, ensure that cooling air can  
8 pass through the junction unit 31 from face 33 to face 33, without significant  
9 constriction. Since the junction unit 31 is open at its top 37, a sufficient amount of  
10 cooling air is branched off upwardly, when a floor panel 3a with cooling air outlets 6 is  
11 disposed directly above the junction unit 31.

12 As shown in Fig. 1, the bundles of permanent data cables 12 which are  
13 permanently connected to the connectors 48 are branched off from the cable bunch 9  
14 under the junction unit 31 and run upwardly at its lateral sides between the two faces  
15 35 of the junction unit 31, where they are fixed to one or more sidebars 35. Above the  
16 sidebar 35 appropriate for the level or the connector row 47 to be connected, they are  
17 bent inwardly to reach the rear sides of the respective connectors 48.

18 The cabling described so far, is permanent, i.e. it is not changed when the  
19 configuration of computers 5 to be connected is changed. Rather, the part of the  
20 cabling which is adaptable to a particular computer configuration is constituted by the  
21 patch cables 19 with suitable cable connectors 20 and both ends. The (typically  
22 flexible) patch cables 19 connect the connectors 48 with computer ports 21. They are  
23 plugged in the connectors 48 of the junction unit 31 from the outside and run  
24 downwardly on the lateral edges of the faces 33 to the base floor 1, and on the base  
25 floor 1 towards the computer 5 to be connected, run upwardly and pass through the  
26 cable aperture 7 next to the computer 5 to be connected, and then run on the raised  
27 floor 4 to the computer 5.

28 Figs. 2 to 4 show in more detail side, front and top views of the underfloor  
29 cable junction unit 31 of Fig. 1. Also shown in Figs. 2 to 4 are the surrounding parts of  
30 the raised-floor structure. The top view of Fig. 4 illustrates what is seen from above if  
31 the floor panel 3 over the cable junction unit 31 is removed.



1           The cable junction unit 31 is made up of face parts 34, sidebars 35 and  
2   slide-in units 38. The face part 34 is portal-like and has an upper horizontal bar 39,  
3   two vertical lateral bars 40 and lower horizontal projections 41 (the terms "horizontal"  
4   and "vertical" refer to the normal installation position of the junction unit 31). The  
5   horizontal projections 41 each have a mounting hole 42 (preferably an elongated  
6   hole) and a grounding pin 43. In other embodiments a horizontal bottom bar 41a (Fig.  
7   6) connecting the two lateral bars 40 is provided instead of the two horizontal bars 41.  
8   Since the portal is then closed, its stability is improved. These embodiments with  
9   closed portal are used when the junction unit is installed on the base floor 1 prior to  
10   the laying of the cable bunches 9.

11           The vertical lateral bar 40 has a vertical row of threaded holes 44 at its face  
12   and, at right angles, another vertical row of threaded holes 45 at its lateral side. Slide-  
13   in units 38 and patch cable guiding elements 46 can be fixed to the face part 34 at  
14   variable levels by means of screws 49 using one or more of the threaded holes 44 on  
15   the appropriate level. Similarly, the sidebars 35 can be fixed to two face parts 34 on a  
16   desired level by means of screws 50 in one or more of the threaded holes 45. The  
17   cable guiding elements 46 resemble a fork, the outer end of which is partly closed.  
18   The threaded holes 44, 45 are arranged at equal spaces between adjacent holes.  
19   This defines a discrete height raster and enables the slide-in units 38 and sidebars  
20   35 to be easily mounted horizontally and in predefined heights.

21           In other embodiments (not shown) continuously lockable clamps can be  
22   provided for mounting the slide-in units 38, the cable guiding elements 46 and/or the  
23   sidebars 35 instead of the above-described screw and threaded-hole arrangement.

24           The sidebars 35 are equipped with holes 51 at their ends to enable them to  
25   be mounted laterally to two opposing face parts 34 by means of screws 50 and  
26   threaded holes 45, as described above. The upper and lower edges of the sidebars  
27   35 have a comb-like shape with upwardly and downwardly extending tines 50.

28           The slide-in units 38 include the rows 47 of connectors 48. They are standard  
29   units, preferably with a width of nineteen inches. Each slide-in unit 38 has twenty-four  
30   RJ45, RJ11, 25-pin sub-D, V35, X21, SC, ST, E2000, MTRJ or LC connectors. The  
31   slide-in units 38 are provided with enclosures 53 which protect the interior of the

1 connectors 48. Slide-in units 38 may be equipped with feed-through connectors, for  
2 example optical feed-through connectors of the E2000 system or RJ45 copper feed-  
3 through connectors (i.e. female snap-in connectors). In Figs. 2 and 4, one the  
4 connector rows is a row of RJ45 Category 6 feed-through connectors, denoted by  
5 48a', whereas the other RJ 45 connectors are Category 5 connectors, denoted by  
6 48a. Optionally, the slide-in units 38 can be equipped with lateral cable guides 57 in  
7 the form of downwardly curved troughs (Fig. 5) which are an additional means  
8 besides the sidebars 35 of ensuring that the bending radius does not fall below the  
9 required minimum value. This is particularly advantageous for slide-in units with  
10 optical connectors. Since the cable guides 57 stand over laterally, a slide-in unit 38  
11 with already mounted cable guides 57 has to be tilted to enable the slide-in unit 38 to  
12 be slid into or pulled out of the junction unit 31. Alternatively, the cable guides 57 are  
13 mounted to the slide-in units 38 before they are slid into the junction unit 31. The slide-  
14 in units 38 are equipped with holes near their lateral edges to enable them to be  
15 mounted at the faces 33 of the cable junction unit 31 by means of the screws 49 in the  
16 threaded holes 44 on an appropriate level.

17 In order to assemble the cable junction unit 31 from the above-described  
18 pieces, two or more sidebars 35 are mounted to each side of two opposing face  
19 parts 34 (for installations with a low-raised floor, only one sidebar per side may be  
20 sufficient). The resulting frame is a tube-shaped open frame. The height at which the  
21 sidebars 35 are mounted depends on the height at which the slide-in units 38 are  
22 mounted and which type of data cable is used. The height is to be chosen  
23 appropriately so that the data cables to be fixed to the sidebars 35 are not bent  
24 beyond the required minimum bending radius. The required number and type of slide-  
25 in units 38 are slid into the portal-like opening of the face parts 34 from the outside  
26 and secured by means of the screws 49 in the holes 44. This is done in such a  
27 manner that slits 36 remain free between the units 38. In the example shown in Figs. 2  
28 to 4 five units 38 with copper cable connectors 48a and one unit 38 with optical  
29 connectors 48b has been mounted.

30 The assembled junction unit 31 is then fixed to the base floor 1 using the  
31 mounting holes 42. The unit 31 is dimensioned such that it can be lowered through a

1 module opening of an already installed raised-floor system. Since the embodiment  
2 shown in Figs. 2 to 4 has no horizontal bottom bar, it can be installed above an  
3 already existing cable bunch 9. However, if the cables are only laid after the  
4 installation of the junction unit 31, another embodiment with such a horizontal bottom  
5 bar is preferred.

6 The bundles of permanent data cables 12 which are to be connected to the  
7 connectors 48 of the junction unit 31 are branched off from the cable bunch 9 running  
8 through the junction unit 31 between the face parts 34. They run upwardly at the  
9 junction unit's lateral sides, where they are fixed to the sidebars 35 with cable ties 54.  
10 Above the appropriate sidebar 35 they are bent inwardly to the rear side of the  
11 connectors 48 to which they are permanently connected. If an optical break-out cable  
12 is used, it is fixed in such a manner that the bundle cable (denoted with "12a" in Fig.  
13 3) as a whole is fixed to the sidebar 35, and the point where the bundle cable 12a is  
14 split up into individual optical fiber cables (denoted with 10a in Fig. 3) is above the  
15 corresponding sidebar 35.

16 The patch cables 19 are plugged into the connectors 48 and are inserted into  
17 the lateral cable guiding elements 46 so that they first run nearly horizontally from the  
18 connectors 48 to the sides of the junction unit 31 and, from there downwardly, guided  
19 by the cable guiding elements 46 to the base floor 1, thereby maintaining free access  
20 to the lower connector rows 47. The cable guiding elements 46 ensure that the patch  
21 cables 19 run in an ordered manner aligned with the vertical lateral bars 40 and the  
22 front faces of the slide-in units 38, so that the connectors 48 of the different rows 47  
23 remain accessible and the air flow resistance of the cabled junction unit 31 is not  
24 much increased by the patch cables 19. They also function as a traction relief; i.e. a  
25 patch cable 19 can not be unplugged by pulling on it from the computer connector  
26 end.

27 The cable junction unit 31 can be used in a flexible way: different types of  
28 connector can be used in one and the same junction unit 31. The number of  
29 connectors 48 can be varied within certain limits (in special circumstances, it is even  
30 possible to fill the slits 36 with additional slide-in units 38); in an already installed  
31 junction unit 31 the number and type of connector can be changed; the junction unit 31

1 can be installed in existing installations with a plurality of cables already running on  
2 the base floor; by using shorter or longer sidebars 35 the junction unit 31 can be,  
3 within certain limits, adapted to differently sized floor modules.

4 Fig. 6 illustrates schematically another embodiment which adjustable height  
5 and width. The height adjustability is achieved by a telescopic design of the vertical  
6 lateral bars, the two telescopic parts are denoted with 40a and 40b in Fig 6. Similarly,  
7 the width adjustability is achieved by a telescopic design of the sidebars, the two  
8 telescopic parts are denoted with 35a and 35b in Fig 6. A desired height and width  
9 can, for example, be secured by screws 49 and 50a. It is clear that embodiments with  
10 either height adjustability without width adjustability or width adjustability without  
11 height adjustability are also useful, depending on particular needs. The above and  
12 following description of technical features of the junction unit 31 and the computer  
13 room 32 also applies to such embodiments with adjustable height and or width.

14 Fig. 7 is a schematic top view of a computer center equipped with underfloor  
15 cable junction units 31 as shown in Figs. 1 to 4. The computer center comprises a  
16 computer room 32 and a data communication room 55. The computer room 32  
17 houses a plurality of computers 5, whereas the data communication room 55 houses  
18 active network elements 56, such as routers, switches etc. to which the computers 5  
19 are connected. The major part of the length of these connections is provided by the  
20 permanently installed data cables 10 (or bunches 9 of such cables) which  
21 permanently link network element junction units 57 located in the data communication  
22 room 55 with a plurality of (the above-described) underfloor cable junctions 31 which  
23 are distributed throughout the computer room 32 under the raised floor 4 (six such  
24 junction units 31 are depicted in Fig. 5). First patch cables 19 connect the computers  
25 5 with nearby underfloor cable junction units 31, and second patch cables 58 provide  
26 connections between the network element junction units 57 and the respective active  
27 network elements 56, as required for a particular configuration of computers 5 and  
28 active network elements 56. If the configuration changes, which is often the case in a  
29 computer center, only the first and/or second patch cable connections have to be  
30 changed.

1           With the embodiments, a high port density can be achieved which enables a  
2 computer center to be equipped with a higher density of computers. Despite the high  
3 port density, the forming of hot spots above the cable junction units is avoided. Due to  
4 their elaborate, but at the same time simple and modular design, the costs for  
5 manufacturing and installing the embodiments and for laying the permanent and patch  
6 cables are considerably lower than for prior art designs.

7           All publications and existing systems mentioned in this specification are  
8 herein incorporated by reference.

9           Although certain products constructed in accordance with the teachings of  
10 the invention have been described herein, the scope of coverage of this patent is not  
11 limited thereto. On the contrary, this patent covers all embodiments of the teachings  
12 of the invention fairly falling within the scope of the appending claims either literally or  
13 under the doctrine of equivalence.